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CLINICAL GUIDELINE

Red Cell Transfusion in Acute Myocardial Infarction: AABB International Clinical Practice Guidelines

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Description: Optimal transfusion strategies for patients with acute myocardial infarction (AMI) are uncertain. The aim of this guideline is to provide recommendations for red blood cell transfusion in patients with AMI.

Methods: These guidelines are based on evidence from randomized controlled trials of patients presenting with AMI and assigned to 2 different transfusion strategies (restrictive or liberal) based on hemoglobin concentrations or hematocrit levels before receipt of a transfusion. A meta-analysis of eligible trials was performed using Cochrane methods. The international panel followed GRADE (Grading of Recommendations Assessment, Development and Evaluation) methods to summarize evidence and formulate recommendations. This guideline's primary perspective is that of the patient, including medical, financial, and psychological effects, with secondary consideration of health care system issues, particularly conservation of the limited and costly blood supply.

Recommendation: For hospitalized patients with AMI, the panel suggests a liberal red cell transfusion strategy when the hemoglobin concentration is less than 10 g/dL (conditional recommendation, low-certainty evidence). A restrictive strategy of 7 to 8 g/dL may result in increased mortality in patients with AMI. The direction of the recommendation for the liberal strategy was based on the great importance of mortality for patients. The conditional recommendation was based on the low certainty of evidence and the competing consideration of blood supply conservation. Clinicians should adopt mitigation strategies to reduce potential adverse events associated with a liberal transfusion strategy, and all transfusion decisions should incorporate the clinical context rather than solely the hemoglobin concentration.

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Threshold-driven indications for red blood cell (RBC) transfusion based on hemoglobin (Hb) concentration are common in clinical practice. International guidelines from the Association for the Advancement of Blood & Biotherapies (AABB) have previously evaluated the data from all randomized controlled trials (RCTs) comparing liberal versus restrictive transfusion thresholds across multiple medical and surgical settings and have made general recommendations for restrictive strategies for RBC transfusion using an Hb threshold of less than 7 g/dL (1). Restrictive strategies minimize patients' exposure to the risks of unnecessary transfusions and mitigate blood shortages. However, the relative risks and benefits of different strategies for RBC transfusion in some selected populations are uncertain.

More than 3 million new cases of acute myocardial infarction (AMI) occur each year, with approximately 1 million deaths in the United States (2). Recurrent MI is an important complication after AMI, with rates reaching 2.5% at 90 days (3). Patients with AMI often present with anemia, with reported rates up to 40% in elderly persons (4). Given imminent new trial data that were unavailable at the time, a recent international AABB guideline panel chose not to provide RBC transfusion recommendations for this population. There are reasons that the safety of a restrictive transfusion strategy in many other populations may not apply to AMI. The healthy oxygen extraction ratio within the coronary circulation is 60% to 70%, potentially increasing ischemic risk from anemia during pathologically decreased coronary flow (5). The increased Hb concentration from a liberal RBC transfusion strategy may therefore result in an important improvement in oxygen delivery to the myocardium and, ultimately, better patient outcomes. At the same time, however, transfusion increases intravascular volume and may result in pulmonary edema, circulatory overload, or other transfusion-related adverse events, increasing morbidity and mortality.

Two groups of investigators have published large RCTs–the MINT (Myocardial Ischemia and Transfusion)

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trial (6) and the REALITY (Restrictive and Liberal Transfusion Strategies in Patients with AMI) trial (7)–that tested the effect of RBC transfusion based on 2 different Hb thresholds on patient-important AMI outcomes. Although the designs of both trials were similar, they reported different directions of effect for key outcomes. It is therefore timely to review the current literature examining RBC transfusion thresholds in patients with AMI and provide recommendations.

METHODS FOR GUIDELINE DEVELOPMENT PROCESS

This work followed recognized standards for GRADE (Grading of Recommendations Assessment, Development and Evaluation) methods to summarize evidence and formulate recommendations (8, 9).

Steering Committee and Panel Composition and Conflicts

The Steering Committee (S.J.S., M.B.P., J.D., and G.H.G.) planned analyses, presentation of evidence, and the process of moving from evidence to recommendation. The AABB, through its Clinical Transfusion Medicine Committee, commissioned the guideline in March 2024 and recruited all participants from a previous panel as well as experts representing relevant international organizations (**Appendix**, available at Annals.org). The Steering Committee began the meta-analysis in April 2024, and the panel first met virtually in June 2024 to finalize the PICO (population, intervention, comparator, and outcome) question and define minimal important differences (MIDs) and relevant outcomes of interest. The panel reviewed the results of the meta-analysis and drafted recommendations in September 2024. The guideline manuscript was finalized in February 2025. The international panel included members with relevant multidisciplinary expertise (including cardiology, critical care, hematology, transfusion medicine, anesthesiology, and internal medicine), 2 patient partners (A.D. and N.H.S.), and 2 methodologists (J.D. and G.H.G.). Individual members disclosed potential financial, professional, or personal conflicts of interest. Primary investigators on trials (J.L.C. and P.G.S.) provided their perspectives to the guideline panel but recused themselves from voting on recommendations. The vote on the final recommendation was anonymous; 3 members of the panel did not support a recommendation for a liberal strategy, and in the final vote, the majority (70%) of the panel voted for a recommendation of an Hb concentration below 10 g/dL versus a range of 9 to 10 g/dL.

Scope: PICO Question

The PICO question was as follows: For hospitalized patients with AMI, should RBC transfusion be initiated with an Hb threshold of 7 to 8 g/dL or an Hb threshold of less than 9 to 10 g/dL?

Given that the trials enrolled only patients with AMI, we provide recommendations solely for this patient population. The panel recognizes that transfusion decisions are more challenging in patients with hemodynamic instability in whom there is pulmonary edema and volume overload and/or oxygen supply–demand mismatch without volume overload. Although the former responds to diuresis, the latter may respond to RBC transfusion. Therefore, the panel's recommendation applies only to those without hemodynamic instability.

Perspective

This guideline's primary perspective is that of the patient, including medical, financial, and psychological effects, as opposed to that of the health care system (10). Given that the global blood supply is a limited and costly resource, the panel also considered secondary public health issues that are relevant for the global blood supply.

Values and Preferences Underlying the Recommendation

The values and preferences underlying the recommendation reflect the life-threatening context of AMI and include mortality and reduction of the risk for recurrent MI (high value), severe adverse events after RBC transfusions (high value), and conservation of the RBC supply (moderate value). Overall, the panel places a higher value on the uncertain potential benefits of a liberal strategy on reducing mortality than the unequivocal benefits of a restrictive strategy in conserving RBC units and reducing transfusion-related severe adverse events.

Outcomes and MID

To rate the importance of outcomes of interest (**Supplement Table 1**, available at Annals.org) and identify what patients with AMI might consider as a threshold of MID for benefit or harm in important outcomes (30-day all-cause mortality, recurrent MI, transfusion-related severe adverse events, stroke, and acute heart failure) (**Supplement Table 2**, available at Annals.org), the panel members completed surveys that reflected their opinions on what patients might value. These surveys established MIDs for 30-day mortality and severe adverse events. The Steering Committee extrapolated survey results to propose MIDs for recurrent MI, stroke, and congestive heart failure that the panel reviewed and adopted (**Supplement Table 3**, available at Annals.org). Panelists defined transfusion-related severe adverse events as events associated with respiratory and circulatory symptoms. The MINT investigators classified these events as anaphylaxis, transfusion-associated circulatory overload (TACO), and transfusion-related acute lung injury (TRALI), whereas the REALITY investigators used categories of anaphylaxis, acute respiratory distress syndrome, and acute heart failure.

Comments and Modification

The Steering Committee prepared the initial manuscript drafts. Authors, including international partners,

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reviewed and edited drafts and approved the final manuscript. The AABB Board of Directors provided a final review and approval.

Evidence Review and Rating

Systematic Review

The panel developed this recommendation on the basis of a systematic review of the relevant evidence (11). We identified 4 trials that met eligibility criteria, based on repeated searches through April 2024. The meta-analysis focused the primary analysis on RCTs of patients presenting with AMI who were assigned to 2 different transfusion strategies (restrictive or liberal) based on Hb concentrations or hematocrit levels before receipt of a transfusion. Randomly assigned patients in the trials were excluded from the present analysis if they did not have AMI. Risk of bias was evaluated using the Cochrane Risk of Bias 2 tool, in which assessments are undertaken by outcomes (12).

We performed meta-analyses according to standard Cochrane methods, with 2 key deviations from the methods used in the original review (11). We used a fixed-effects model rather than a random-effects model given the focused nature of our commission. For the purposes of the analysis, we also took the approach of considering the liberal threshold strategy as the intervention and the restrictive strategy as standard practice, as this is now the case in clinical practice. Therefore, we inverted previous data entry and presentation as used in the Cochrane review (11), and the GRADE Summary of Findings table presented here now considers judgments based on an assessment of the appropriateness of increasing the recommended threshold.

Analysis

All analyses were performed using Cochrane Review Manager 5 (13). Risk ratios (RRs) and odds ratios (ORs) with 95% CIs were calculated using fixed-effects models (Mantel–Haenszel approach) for most outcomes; for those where events were rare (for example, expected at ≤1%), we used the Peto OR. Absolute risk differences were calculated by applying ORs to estimated baseline risks (14).

Grading the Certainty of the Evidence and Formulating Recommendations

GRADE guidance informed overall risk of bias, imprecision, indirectness, and inconsistency judgments (15). We summarized evidence using GRADE Summary of Findings tables (16), including judgments regarding evidence certainty, and the panel formulated recommendations using the GRADE evidence-to-decision framework (17).

RESULTS

Recommendation

For hospitalized patients with AMI, the international panel suggests RBC transfusion when the Hb is less than 10 g/dL (conditional recommendation, low-certainty evidence).

Good Practice Statement

For hospitalized adult patients with AMI, it is important to incorporate the clinical context (e.g., patients' history, signs, symptoms, hemodynamic status) and patients' preferences when weighing RBC transfusion decisions.

Remark

In accordance with the increased risks of severe adverse events in the liberal transfusion strategy, clinicians should consider strategies for mitigation of adverse transfusion events. Strategies include optimizing fluid status peri-transfusion, slowing transfusion rate, prescribing diuretics, achieving the target Hb more gradually, and transfusing during renal replacement therapy sessions for renal failure.

Evidence Summary

The analysis identified and considered 4 eligible trials enrolling 4311 participants (**Table 1**). The MINT trial enrolled 3504 participants, and the REALITY trial included 666 participants (6, 7). A study by Carson and colleagues (18) was a pilot trial with 110 participants (14 without AMI who are not included in the current analysis), and a study by Cooper and colleagues (19) was a single-institution trial that included 45 participants with AMI; both of these trials stopped before achieving their initial recruitment targets. Scrutiny of trial registers, including the World Health Organization's International Clinical Trials Registry Platform and ClinicalTrials.gov, revealed no registered work that was eligible but unpublished.

Study outcomes were assessed as having low risk of bias or some concerns overall; no individual trial was rated as having high risk of bias for any domain for any outcome (**Supplement Figure 1**, available at Annals.org). Results of the meta-analysis of included outcomes are presented in **Supplement Figure 2** (available at Annals.org).

Table 2 presents the summary of findings for comparison of restrictive versus liberal transfusion strategies in patients with AMI for outcomes of 30-day mortality, recurrent MI, congestive heart failure, serious adverse events, stroke, acute kidney injury, and exposure to transfusion. A liberal transfusion strategy resulted in approximately 3.5 times more transfusions, with 34% of patients in the restrictive groups and 96% in the liberal groups receiving any transfusion (high certainty).

All 4 trials ($n = 4311$) evaluated 30-day mortality, with a pooled RR of 0.87 (95% CI, 0.72 to 1.06). The absolute risk difference estimate between transfusion strategies indicated 1.2% fewer deaths with a liberal strategy. This estimate surpassed the panel-defined MID of 1%.

The MINT trial reported a high rate of recurrent MI at 30 days in both groups (7.2% in the liberal group and 8.5% in the restrictive group), more than double the rate reported in the REALITY trial (3.1% in the liberal group and 2.1% in the restrictive group), with a

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Table 1. Clinical Trials That Included Patients With AMI

Study, Year (Reference)	Design	Baseline Characteristics (Restrictive Group vs. Liberal Group)	Therapeutic Intervention (Restrictive Group vs. Liberal Group)	Thresholds (Restrictive Group vs. Liberal Group)	Primary Outcome	Main Results (Restrictive Group vs. Liberal Group)	Methodological Considerations
Cooper et al, 2011 (19)	RCT, 2 sites Enrollment: 2003–2009 Follow-up: 30 d	STEMI: 46% vs. 33% NSTEMI: 54% vs. 67% Transfusion before randomization not reported	PCI: 54% vs. 57%	Hematocrit level <24% (n = 21) Hematocrit level <30% (n = 24)	In-hospital death Recurrent MI CHF	30-day mortality: 8.3% vs. 4.8% AMI: 0% vs. 4.8% CHF: 12.5% vs. 42.8% Serious AEs: None	Small sample size Pilot Potentially important imbalances at baseline
Carson et al, 2013 (18)	RCT, 8 sites, pilot Enrollment: 2010–2012 Follow-up: 6 mo	STEMI: 29.1% vs. 30.9% NSTEMI: 47.3% vs. 38.2% Transfusion before randomization not reported	PCI: 47.3% vs. 63.6%	Hb concentration <8 g/dL (n = 55) Hb concentration <10 g/dL (n = 55)	Death Recurrent MI Unscheduled revascularization	30-day mortality: 12% vs. 2.2% AMI: 14% vs. 10.9% CHF: 12% vs. 4.3% Serious AEs: None	Small sample size Pilot Not all patients had AMI (although data used here are only from those with AMI) Some imbalances at baseline Myocardial infarction and heart failure were centrally adjudicated
Ducrocq et al, 2021 (7) (REALITY)	RCT, 35 sites, 2 countries, noninferiority Enrollment: 2016–2019 Follow-up: 1 y	NSTEMI: 68.4% vs. 71.3% Transfusion before randomization not allowed	PCI: 58.8% vs. 59.3%	Hb concentration <8 g/dL (n = 342) Hb concentration <10 g/dL (n = 324)	Major adverse cardiovascular events	30-day mortality: 5.6% vs. 7.7% AMI: 2.1% vs. 3.1% CHF: 3.2% vs. 3.7% Serious AEs: 4.4% vs. 5.9%	All elements of the primary efficacy outcome, including MI as well as acute heart failure, were centrally adjudicated Low rate of protocol discontinuation (4.4% [restrictive] vs. 0.6% [liberal]) No statistical analysis was performed for secondary outcomes, including type 1 and type 2 MI, given the potential for type I error Unclear acute kidney failure and adverse events classifications, which were local site decisions and, except for acute heart failure, were not centrally adjudicated Statistical significance for superiority was not met, requiring larger trials
Carson et al, 2023 (6) (MINT)	RCT, 144 sites, 6 countries, open-label, phase 3 Enrollment: 2017–2023 Follow-up: 6 mo	NSTEMI: 81.8% vs. 80.8% Type 1 MI: 41.7% vs. 41.6% Type 2 MI: 55.3% vs. 56.3% Transfusion before randomization: 34.2% vs. 36.4%	PCI: 29.1% vs. 28.1%	Hb concentration <8 g/dL permitted; <7 g/dL strongly recommended (n = 1749) Hb concentration <10 g/dL (n = 1755)	Composite of MI or death	30-day mortality: 9.9% vs. 8.5% AMI: 8.5% vs. 7.2% CHF: 5.8% vs. 6.3% Serious AEs: 0.6% vs. 2%	Myocardial infarction was the only trial outcome that was centrally adjudicated Significant number of transfusions before randomization Imbalance of rates of protocol discontinuation (2.6% [restrictive] vs. 13.7% [liberal]) Cardiac deaths as an additional outcome were not centrally adjudicated

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Table 1–Continued

Study, Year (Reference)	Design	Baseline Characteristics (Restrictive Group vs. Liberal Group)	Therapeutic Intervention (Restrictive Group vs. Liberal Group)	Thresholds (Restrictive Group vs. Liberal Group)	Primary Outcome	Main Results (Restrictive Group vs. Liberal Group)	Methodological Considerations
							MINT investigators stated that subgroup analysis was not adjusted for multiplicity. The observed differences for type 1 and type 2 MI might be explained by chance (*P* for interaction = 0.16) (28). Unclear adverse events classification, which was a local site decision and was not centrally adjudicated

AE = adverse event; AMI = acute myocardial infarction; CHF = congestive heart failure; Hb = hemoglobin; MI = myocardial infarction; MINT = Myocardial Ischemia and Transfusion; NSTEMI = non–ST-segment elevation myocardial infarction; PCI = percutaneous coronary intervention; RCT = randomized controlled trial; REALITY = Restrictive and Liberal Transfusion Strategies in Patients with AMI; STEMI = ST-segment elevation myocardial infarction.

pooled RR of 0.88 (CI, 0.71 to 1.09). The absolute difference in recurrent MI between transfusion strategies was 0.9%, indicating moderate certainty of little or no difference given the panel-defined MID of 2%.

Two trials described severe adverse events, although definitions varied. The REALITY trial reported incidence of acute lung injury of 2.2%, whereas the MINT trial reported incidence of 0.3%. These rates are higher than those reported in the general hospital population, with reported pooled TRALI estimates for active surveillance studies of approximately 0.17 (CI, 0.03 to 0.43) cases per 10 000 persons for RBCs (20, 21). The pooled OR was 2.21 (CI, 1.42 to 3.45) for severe adverse events, with higher rates in the liberal group (2 trials; $n = 4170$). The absolute difference between transfusion strategies was 1.4%, with low certainty of little or no effect given the panel-defined MID of 2.5%.

There were no apparent differences between transfusion strategies for other outcomes, including congestive heart failure, stroke, and acute kidney injury.

Rationale for the Recommendation

The 1.2% overall estimated benefit in 30-day mortality exceeded the panel-defined MID, supporting the potential benefit of a liberal transfusion strategy. Moreover, there was moderate-certainty evidence that the liberal strategy does not result in an important increase in mortality. A higher incidence of transfusion-related adverse events in the liberal group, in which transfusion was almost universal and participants received 3 times more units compared with the restrictive group, might be expected, although the difference between strategies was less than the panel's chosen MID. Given that the panel's perspective of considering value and preferences placed higher value on the uncertain potential benefits of a liberal strategy in reducing mortality rather than the unequivocal benefits of a restrictive strategy in conserving RBC units and reducing transfusion-related severe adverse events, the panel agreed on a conditional recommendation in favor of the higher threshold.

Clinical Considerations

- This guideline evaluated the optimal Hb threshold for RBC transfusion in patients with AMI and provides a conditional recommendation to use a liberal transfusion threshold.
- As with any medical intervention, risks and benefits should be weighed before deciding whether to proceed with a transfusion.
- A liberal threshold up to 10 g/dL might not apply to all patients with AMI, and current evidence does not allow for identification of patients with AMI who would benefit the most from a liberal threshold.
- There are almost no clinical scenarios that would preclude transfusions except very rare situations of near fatal anaphylactic or hemolytic reactions or impossibility of finding compatible blood. Blood availability might be a limiting factor in some geographic areas.
- The panel considered the importance of implementing appropriate risk mitigation strategies in patients at risk for severe adverse reactions, such as those with circulatory overload. These approaches include but are not limited to the following: 1) risk stratification for TACO, 2) optimizing fluid status in the peri-transfusion period, 3) slowing the RBC infusion rate, 4) peri-transfusion diuresis, 5) achieving the target Hb concentration more slowly, and 6) transfusing during renal replacement therapy for patients acutely or chronically requiring such therapy (22).
- Due to the higher risk for serious adverse events associated with the suggested transfusion strategy, clinicians

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Table 2. Summary of Findings Table for a Liberal Threshold Compared With a Restrictive Threshold for Guiding Red Blood Cell Transfusion

Outcome	Patients (Trials), *n*	Relative Effect (95% CI)	Absolute Effects			Certainty	Plain Language
			Restrictive Threshold	Liberal Threshold	Difference (95% CI)		
30-day mortality	4311 (4 trials)	RR, 0.87 (0.72 to 1.06)	93 per 1000	81 per 1000	12 fewer per 1000 (26 fewer to 6 more)	⊕⊕⊖⊖* Low ⊕⊕⊕⊖† Moderate	A liberal transfusion threshold may decrease mortality at 30 days (low-certainty evidence). A liberal transfusion threshold likely does not result in an important increase in mortality at 30 days (moderate-certainty evidence).
Recurrent myocardial infarction	4311 (4 trials)	RR, 0.88 (0.71 to 1.09)	75 per 1000	66 per 1000	9 fewer per 1000 (22 fewer to 7 more)	⊕⊕⊕⊖‡ Moderate	A liberal transfusion threshold likely has little or no effect on the incidence of myocardial infarction at 30 days (moderate-certainty evidence).
Serious adverse events	4170 (2 trials)	OR, 2.21 (1.42 to 3.45)	12 per 1000	26 per 1000	14 more per 1000 (5 more to 28 more)	⊕⊕⊖⊖§ Low	A liberal transfusion threshold possibly has no important effect on serious adverse events (defined as anaphylaxis, transfusion-related lung injury, or circulatory overload) (low-certainty evidence).
Stroke	4311 (4 trials)	OR, 0.91 (0.55 to 1.50)	15 per 1000	13 per 1000	1 fewer per 1000 (7 fewer to 7 more)	⊕⊕⊕⊕ High	A liberal transfusion threshold has no important effect on the incidence of stroke (high-certainty evidence).
Congestive heart failure	4311 (4 trials)	RR, 1.11 (0.88 to 1.41)	56 per 1000	63 per 1000	6 more per 1000 (7 fewer to 23 more)	⊕⊕⊕⊖‡ Moderate	A liberal transfusion threshold likely has no important effect on the incidence of congestive heart failure (moderate-certainty evidence).
Acute kidney injury	4207 (3 trials)	RR, 0.96 (0.82 to 1.13)	126 per 1000	121 per 1000	5 fewer per 1000 (23 fewer to 16 more)	⊕⊕⊕⊕ High	A liberal transfusion threshold does not result in an important difference in risk for acute kidney injury (high-certainty evidence).
Exposure to blood transfusion	4324 (4 trials)	RR, 2.81 (2.65 to 2.98)	341 per 1000	957 per 1000	616 more per 1000 (562 more to 674 more)	⊕⊕⊕⊕ High	A liberal transfusion threshold results in an important increase in risk for exposure to blood transfusion (high-certainty evidence).

MID = minimal important difference; OR = odds ratio; RR = risk ratio.
* We have rated down for inconsistency (I^2 of 39%, with the 2 largest trials differing) and imprecision when considering a potential decrease in mortality.
† When considering the potential for an increase in mortality, we have rated down for inconsistency but not for imprecision, being mindful of the MID set at 1%.
‡ We have rated down for imprecision because with an MID of 2%, the CI includes both an important effect and an unimportant effect.
§ We have rated down for important inconsistency (I^2 of 70% between 2 large trials [1, 2]) and because the CI includes both an important effect and an unimportant effect.

should personalize each transfusion decision and informed consent discussion.
- Clinicians should adopt general approaches to mitigate the risk for anemia through the deployment of patient blood management strategies, including minimizing unnecessary blood testing, use of low-volume sample collection tubes, and early recognition and treatment of underlying causes of anemia.

Outcomes of Interest

The panel considered the evidence from 4 trials, recognizing that most of the data were derived from the MINT trial (86% weight for the 30-day mortality meta-analysis). The MINT and REALITY trials were rated at low risk of bias for the key outcomes, and the 1.2% overall estimated benefit in 30-day mortality exceeded the panel-defined MID. The results provided moderate-certainty evidence that the liberal strategy does not result in an important increase in mortality, and there was no compelling evidence of important harm for other outcomes based on the panel-defined MIDs.

The MINT trial suggested reduced mortality with the liberal strategy, whereas the REALITY trial suggested increased mortality. It is possible, given the wide CIs for individual trials, that these differences represent a chance

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finding. Indeed, the CIs for the REALITY trial include the point estimate from the MINT trial, supporting this possibility, and an interaction test for subgroup differences was consistent with chance as an explanation of the difference ($\chi^2 = 2.55$; degrees of freedom = 1 [$P = 0.11$]) (**Supplement Figure 3**, available at Annals.org). Nevertheless, the panel believed that the differences were large enough to rate down the certainty of evidence for inconsistency. Although one might speculate on possible explanations for differences in the main outcomes between both trials (inclusion criteria, type of AMI, proportion undergoing percutaneous coronary intervention, mortality rate, transfusion protocol), chance is a possible explanation.

Benefits and Harms

In patients with AMI, the relative safety of restrictive Hb thresholds as commonly recommended in many populations has been unclear. Reflecting the tension between benefit and risk, some panel members were not confident that the desirable effects of RBC transfusion outweighed all of the undesirable effects in all patients with AMI. The panel then discussed whether the recommendation should adopt an Hb threshold of 10 g/dL, which was evaluated in 3 of the 4 trials, or a threshold range of 9 to 10 g/dL, which some clinicians on the panel believed was appropriate. Although a secondary analysis of the MINT trial raised the hypothesis of an increase in mortality tied to each 1-g/dL decrease in the Hb threshold, the CIs were wide, indicating imprecision (23). A restrictive strategy may result in increased mortality in patients with AMI. Overall, the panel provided a conditional recommendation based on low-certainty evidence for a liberal transfusion strategy using an Hb threshold of less than 10 g/dL for patients with AMI.

Strengths and Weaknesses

The results of our analysis are consistent with recent systematic reviews (24, 25), findings in a recent large population-based study (26), and a guideline on critical illness (27). By comparison, few interventions in AMI have shown mortality benefits of more than 1%, including use of percutaneous coronary intervention versus thrombolytic therapy (28).

A strength of this guideline is the application of robust GRADE methods, including use of a multiprofessional panel of clinicians who are engaged across the spectrum of activities relevant to the care of patients with AMI. The data used to inform the recommendations were from large trials that generated current data reflecting modern practice. Limitations of our work include MID estimates based on limited direct evidence regarding patient values and preferences (**Supplement Table 3**). The guideline recommendation does not apply to patients with acute coronary syndrome or patients without AMI, for whom uncertainty about the safety of restrictive thresholds remains.

Research Gaps

The panel identified several research needs. The liberal transfusion group in both the MINT and REALITY trials applied an Hb threshold of 10 g/dL, but the optimal approach to achieve the most appropriate balance between favorable and unfavorable consequences of RBC transfusion in different AMI populations remains unclear. In the MINT trial, death or recurrent MI at 30 days was more frequent in patients with type 1 MI (atherothrombotic plaque rupture or erosion) who were randomly assigned to the restrictive transfusion strategy compared with the liberal strategy (29). The REALITY trial reported a higher rate of recurrence of AMI in the restrictive group.

Clinically, the benefits and harms of RBC transfusion are likely to vary according to the severity and extent of coronary artery disease and the severity of ventricular impairment after AMI. Benefit might be considered more likely where coronary revascularization is not possible or is incomplete. Persons with residual obstructive disease, particularly where this subtends a large territory or multiple territories, might be at greater risk for recurrent myocardial ischemia, which may be exacerbated by anemia. In contrast, harm might be more likely in those with significant new ventricular impairment or cardiogenic shock after AMI, where transfusion could contribute to volume overload and acute pulmonary edema. Therefore, to identify patients who might benefit more and to personalize the transfusion decision, future research should address the optimal threshold for transfusion according to the mechanism of MI and patient-specific characteristics.

In conclusion, this guideline supports the potential benefit of a liberal transfusion strategy, with a conditional recommendation for an RBC transfusion strategy based on an Hb concentration less than 10 g/dL in patients with AMI.

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Appendix: Additional Contributions

Steering Committee

Members of the Steering Committee were Monica B. Pagano, MD; Simon J. Stanworth, MD, DPhil; Jane Dennis, PhD; and Gordon H. Guyatt, MD.

Panel and Guideline Group Members

The panel included current or former members of the AABB Clinical Transfusion Medicine Committee (Jeffrey L. Carson, MD; Monica B. Pagano, MD; Sara Bakhtary, MD; Claudia S. Cohn, MD, PhD; Brenda J. Grossman, MD, MPH; Gaurav K. Gupta, MD; Aaron S. Hess, MD, PhD; Jessica L. Jacobson, MD; Ryan A. Metcalf, MD; Colin H. Murphy, MD; Micah T. Prochaska, MD; Jay S. Raval, MD; Eric Salazar, MD, PhD; Nabiha H. Saifee, MD, PhD; Aaron A.R. Tobian, MD, PhD; Jonathan Waters, MD; and Nicole D. Zantek, MD, PhD) and the following international organizations: the International Society of Blood Transfusion (Erica M. Wood, MD), the International Collaboration for Transfusion Medicine Guidelines (Katerina Pavenski, MD), the Society of Critical Care Medicine (Lewis J. Kaplan, MD), the European Hematology Association (Cynthia So-Osman, MD, PhD), the Society for the Advancement of Patient Blood Management (Jonathan Waters, MD), and the Society of Hospital Medicine (Micah T. Prochaska, MD).

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